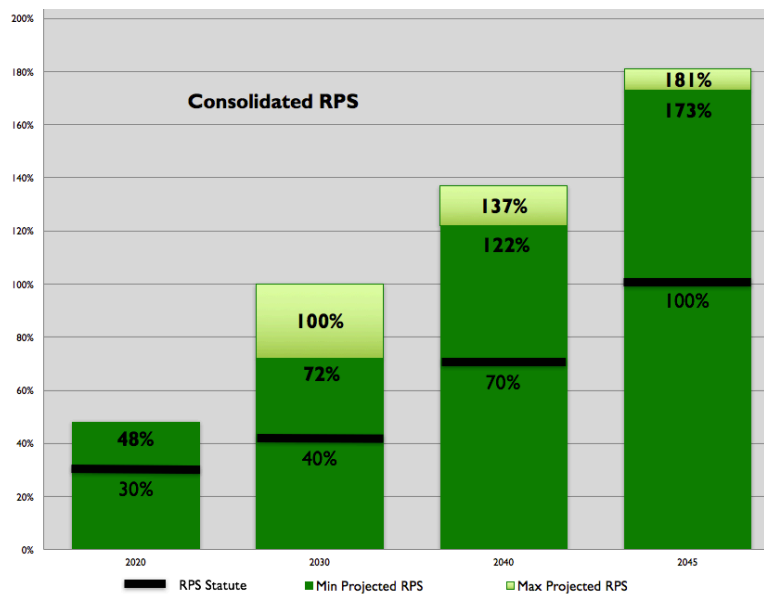


Executive Summary

The Hawaiian Electric Companies' 2016 Power Supply Improvement Plan (PSIP) Update outlines a detailed plan charting the specific actions for the years 2017 through 2021 to accelerate the achievement of Hawai'i's 100 percent Renewable Portfolio Standard (RPS) by 2045.

ATTAINING HAWAI'I'S 100% RPS GOAL

By implementing the proposed action plan, we will exceed the 2020 RPS mandate of 30 percent, achieving an estimated 48 percent, and doubling our 2016 RPS. Under multiple longer-term scenarios, our RPS can be at least 72 percent by 2030 and reach at least 100 percent by 2040, ahead of the 2045 deadline.



Executive Summary

Attaining Hawai'i's 100% RPS Goal

The Power Supply Improvement Plan (PSIP) places greatest emphasis on the near-term actions that allow us to make strong progress on achieving our clean energy goals. These action plans take advantage of available resources, respond to customer preferences, reduce our dependence on oil and its price uncertainty as quickly as possible, while preserving our flexibility over the longer-term to address changing circumstances, to take advantage of new opportunities that may arise, and to explore emerging technologies.

Our PSIP accelerates the pace on the path to 100 percent renewable energy.

The Action Plans:

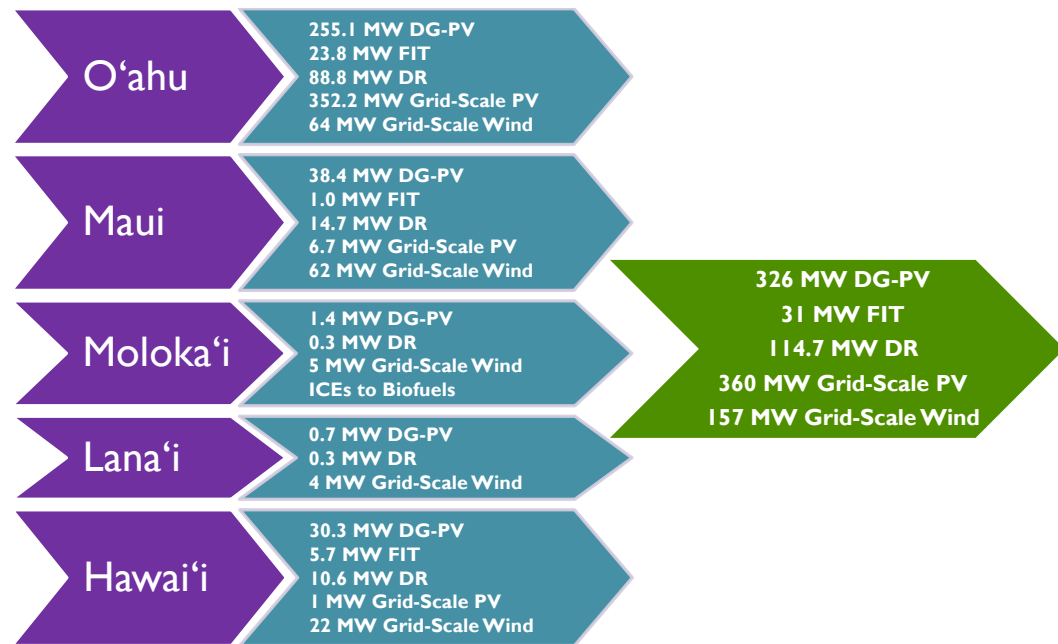
- **Exceed Hawai'i's 2020 Renewable Portfolio Standard (RPS) and achieve a consolidated RPS of 52% over the next five years.**
- **Enable Moloka'i to achieve 100% renewable energy by 2020.**
- **Maximize distributed energy resources—fairly compensated**
- **Make high use of demand response programs.**
- **Aggressively seek grid-scale renewable resources, leveraging federal tax credits.**
- **Pursue grid modernization to enable continued integration of renewable energy.**
- **Preserve long-term flexibility to use emerging technologies and accommodate changing circumstances.**
- **Reduce operations that use fossil fuels and contribute to global warming**

It's important to note that the near-term action plans no longer include liquefied natural gas (LNG), or plans for new combined cycle generation at Kahe. We will continue to evaluate LNG as one alternative in the transition to 100 percent renewable energy.

In the aggregate, our action plans estimate achieving a 52 percent RPS by 2021 by adding 326 megawatts (MW) of rooftop solar, 31 MW of Feed-In Tariff (FIT) solar generation, 115 MW of demand response (DR), 360 MW of grid-scale solar, and 157 MW of grid-scale wind resources across all five islands we serve – an ambitious plan that moves us as a state half-way toward our 100 percent RPS mandate.

Here are the renewable generation and customer demand response additions in our proposed near-term action plans.

2017–2021 Renewable Energy and Demand Response Additions



Achieving the groundbreaking 100 percent goal will require more than a PSIP and the actions of the utility. Rather, it will take *our entire community working together* to make the difficult decisions needed to achieve this clean energy future for our state. All stakeholders – policymakers, government agencies, customers, and private organizations with interests in energy, transportation, agriculture, water use and land use – need to be involved in developing and executing clear policies to guide our choices. Increased energy efficiency, the willingness of communities to accept projects, supportive and adaptive public policies, and partnerships to take advantage of new and improved technology are critical. All of us must support the vision of a future without fossil fuels.

PLAN INFORMS CRUCIAL STATE ENERGY DECISIONS AND ACTIONS

“Hawai'i is the Silicon Valley of clean energy. Hawaiian Electric has played a key role in building this reputation and encouraging innovation”

—Brian Ryan, Vector Limited (New Zealand Energy Excelerator Global Partner)

The Hawaiian Electric Companies’ mission is to provide innovative energy leadership for Hawai'i, to meet the needs and expectations of our customers and communities, and to empower them with affordable, reliable, clean energy. Our goal is to create a modern, flexible, and dynamic grid that enables an optimal mix of distributed energy resources (DER—such as customer-generated rooftop solar PV), DR, and grid-scale resources to

Renewable Energy Planning Principles

- 1. Renewable energy is the first option.** We plan to aggressively pursue cost-effective renewable resource opportunities that work toward lowering generation costs on the grid. Additional renewable resources can be added cost-effectively, ahead of RPS requirements, as the technology of energy storage matures and costs decline. Removing Hawai'i from the volatility of world energy markets gives future generations a tremendous advantage, and creates a clean energy research and development industry for our state.
- 2. The energy transformation must include everyone.** Electricity is essential. Our plans, as well as public policy, should ensure that ratemaking is fair and equitable, and ensure access to affordable electricity—especially those least able to buy self-generation and energy storage.
- 3. Today's decisions must not crowd out tomorrow's breakthroughs.** Our plans keep the door open to developments in the rapidly evolving renewable generation market. We must be able to easily accept new, emerging, and breakthrough technologies that are most cost-effective and more efficient when they become commercially viable.
- 4. The power grid needs to be modernized.** Energy distribution is rapidly moving to the digital age. We must re-invent our grid to facilitate a 100% renewable energy generation portfolio and enable technologies such as demand response, dynamic pricing, grid-edge devices, and electrification of transportation. Flexible generation is also needed to better integrate renewables.
- 5. The lights have to stay on.** Reliability and resiliency of service and quality of power is vital for our economy, for our national security, and for critical societal infrastructure. Our customers expect it, deserve it, and pay for it. All of our plans must maintain or enhance the resiliency of the network—the grid—that delivers energy to the military, businesses, and homes.
- 6. Our plans must address climate change.** Power plants are significant producers of greenhouse gas emissions. We have reduced those emissions more than 15% over the past five years through 2015. Still, our plans must go further to reduce the warming of our planet and to minimize the impacts climate change will have on the energy-delivery network—rising sea levels, coastal erosion, increased temperatures, and erratic storm activity.
- 7. There's no perfect choice.** No single energy source or technology can achieve our clean energy goals and every choice has an impact, whether it's physical or financial. While we can mitigate those impacts, attaining our 100% renewable energy goal has major implications for our land and natural resources, and the state economy. We seek to make the best choices by engaging with customers, regulators, policy makers, and other stakeholders.

achieve these goals. Our near-term action plans provide the context to inform important pending and future resource and system operation actions.

This is not a plan created in isolation and our state must take a holistic view that considers how energy planning can also influence transportation, economic development, land use and job creation.

In addition to the tactics described in this plan, it's important to note that our planners and engineers continue to evaluate alternatives including pumped storage hydropower, run-of-river hydropower, hydrogen storage and production for potential transportation uses, low-temperature geothermal, ocean-wave technology and the identification of customer loads that when coupled with time-of-use rates can be shifted to times when renewable energy is abundant.

This PSIP adhered to several key Renewable Energy Planning Principles. These Principles, described here, will help to guide us through the complete grid transformation that lies before us over the next 30 years.

Here's a closer look at some of the most significant actions and assumptions in this plan.

Strong Growth in Distributed Energy

Resources. We know there is a high level of interest and strong customer participation in our DER programs, especially rooftop solar. Advances in technology continue to drive costs down. Grid-scale renewable resources require large tracts of compatibly-zoned land and community acceptance. To help, we have issued a Request for Information that will help landowners on all islands in our service

territories provide information to potential developers about properties available for grid-scale renewable energy projects. At the same time, we assume high levels of DER penetration and will work to enable the integration of right-sized and right-priced systems. The High DER forecast assumes all single-family residential homes and 20 percent to 25 percent of commercial customers produce the same amount of PV energy as they consume. Over the upcoming months, we will be working with Google's Project Sunroof and Mapdwell's Solar System to provide us with further data on the true potential of DG-PV.

Critical Grid and Generation Modernization. Integrating increasing amounts of customer-supplied DER and grid-scale renewable energy creates a critical need for modernizing the power grid – upgrading and infusing new technologies for our transmission and distribution system utilizing advanced inverters and controls for DER; and judiciously replacing aging, less flexible fossil-fueled units with fast-starting, quick ramping firm generation.

A modernized grid also empowers customer choice where distributed energy resources – solar PV, energy storage batteries, electric vehicles, and demand response resources – can operate at every home.

Modernizing generation means adding fast-starting, quick-ramping flexible units. For example, Waiau unit 8 takes up to four hours to come online; the Schofield generating station currently under construction can provide power to the grid in about one minute and thus can respond to a sudden drop in wind or solar power better than our existing generation fleet. The Schofield Generating Station, strategically located inland and capable of continuing to serve the nearby community in an emergency, is also an example of how the resiliency of the modernized electric system can be bolstered.

Maintaining Reasonable Costs. In developing the action plans, we made concerted efforts to minimize the financial impact on customers. Our near-term action plans include an aggressive deployment of low-cost renewables and a discontinuation of the use of high-carbon dioxide emitting but low-cost coal generation. Despite these renewable additions, the price of oil, the disuse of coal and the cost of modernizing the grid to accept more renewables will move customer bills higher in the near term. However, in the longer term the aggressive pursuit of low-cost renewables will cause customer bills to be flat or slightly declining on a real-dollar basis. The renewable investments in the near-term action plans were selected to minimize the potential for making dead-end decisions and stranding assets. Our approach is to stay flexible to take advantage of breakthrough technologies, especially less expensive ones. A priority is to keep bills manageable as our grid transformation unfolds.

Executive Summary

Plan Informs Crucial State Energy Decisions and Actions

A critical component of affordable bills is rate design. We are exploring options for the evolution of rate design to align with our aggressive transition to more distributed generation and the evolution of the way in which customers provide and receive value from the power network. The rate and bill forecasts in this plan does not yet take these changes into account.

In addition, where military-sited generation is identified in plans, the Company is investigating various ways to reduce the near-term customer bill impacts of these renewable-integrating generators. This could include joint venture arrangements that allow for alternative ownership models while still meeting the electric utility partnership requirements of the military.

Moloka'i 100% by 2020. Although achieving this potential milestone so quickly may cost a little more, what we learn from Moloka'i can serve as a blueprint to increase the cost-effective use of renewables for the rest of the state and help us obtain real world experience in running an island grid with 100 percent renewables. Our longer-term plans allow us to apply any insights we learn on Moloka'i, as well as to take advantage of new and evolving technologies and declining pricing such as for energy storage systems.

We will also continue to collaborate with other island-grid utilities, such as our ongoing working relationship with Okinawa Enetech, Okinawa Electric Power Company, and the National Institute of Advanced Industrial Science and Technology (AIST) to help inform our actions to reach this goal.

Interisland Transmission. Interconnecting the grids on Maui and Hawai'i Island with O'ahu could impact the long-term mix and distribution of renewable generation among the islands—more explicitly, reduce renewable development on O'ahu while increasing it on Maui and Hawai'i Island.

Over the long term, this could lower generation costs. However, the cost of developing and building such an interisland transmission system must be carefully assessed and factored into a benefit and cost analysis. Given the extreme uncertainty surrounding permitting, feasibility and timing, our near-term action plans do not assume the availability of an interisland transmission system. A thorough evaluation of the benefits and costs of such a system would need to be completed before its future practicability can be assessed.

Paths to 100% RPS in 2045. We operate in an increasingly dynamic environment. Technology, prices, policies, and regulations rapidly change. Our action plans are designed to continue to make strong progress on Hawai‘i’s renewable energy goals while preserving flexibility for multiple long-term energy pathways. The Hawaiian Electric Companies are committed to performing energy planning on a continuous basis. This flexibility will allow us to integrate emerging and breakthrough technologies while adjusting to these changing circumstances.

We operate five separate island grids without the ability to export excess energy or import needed energy. Ensuring that today’s choices don’t crowd out future technology and potentially lower pricing is imperative to preserve the ability to achieve Hawai‘i’s clean energy goals at reasonable costs for customers.

Electrification of Transportation. Our action plans also provide a solid foundation for the electrification of transportation, including electric vehicles, docks, airports, and warehouses as well as possible hydrogen fuel cell alternatives, reducing further the use of fossil fuels for ground transportation. And again applying a bigger picture view, electrification of transportation can also help integrate more renewable energy, lower total energy costs for customers, and contribute to a lower carbon footprint. Time-of-use rates create incentives for electric vehicle charging, especially when system load is lower, such as during the daytime when excess solar energy is available. Such energy use shifting can also temper the peak electric load in the evening. Electrification of transportation can also influence the sizing of customer-owned generation to recharge batteries and will also increase the opportunity for greater demand response resources to offset utility investments in storage or generation that would otherwise be needed.

Stakeholder Involvement. We analyzed many scenarios and strategies for attaining our RPS goals. These scenarios included multiple long-term energy scenarios developed by Hawaiian Electric and by PSIP stakeholders, including evaluating the hedge value of renewable energy, assessing LNG as a substitute fuel, considering interisland transmission pooling both firm and renewable resources, valuing generation and grid modernization, and evaluating the impact of site-specific data. As part of this evaluation, we collaborated with PSIP stakeholders, thoughtfully considering their suggestions and input. Here is a sampling of scenarios from several stakeholders along with our general assessment of those scenarios:

Executive Summary

Plan Informs Crucial State Energy Decisions and Actions

Ulupono Initiative. Increased LNG costs by 35 percent to account for a natural hedge value that renewables provide. Our results were similar to not considering LNG at all, a situation that allows for an economic incentive to accelerate and interconnect as much tax- advantaged renewable resources as possible before subsidies expire. The result was similar to our analysis for the next five years, with effectively no difference in renewable procurement decisions.

Hawai‘i Gas. Assessed Hawai‘i Gas’s LNG price forecast for O‘ahu only, which showed a close similarity to our analysis for the next five years, with effectively no difference in thermal and renewable procurement decisions.

Paniolo Power. Researched the cost-effectiveness of pumped storage hydro as a storage option and wind as a renewable option. We found that wind is a beneficial resource to Hawai‘i’s portfolio and wind, in conjunction with battery energy storage, is a more cost-effective combined renewable energy/ storage option for the island of Hawai‘i.

Department of Business, Economic Development and Tourism (DBEDT). Considered DBEDT’s proposed five-step methodology regarding the sensitivity of uncertain variables, especially how interisland transmission could change our action plans. Our evaluations showed that using their process served to increase renewable generation on neighbor islands while decreasing the amount of renewable energy generation added on O‘ahu. As noted earlier, analysis of interisland transmission is ongoing and will not impact near-term action plans.

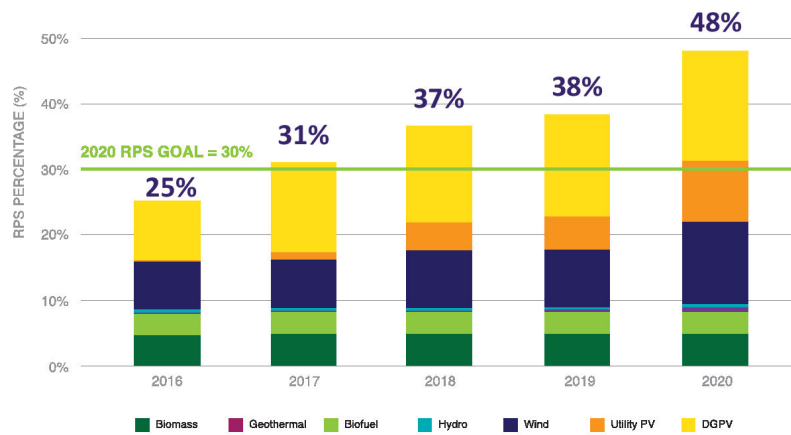
Consumer Advocate. Developed a lowest cost plan without regard to resources or RPS attainment. Results showed that the lowest cost plan included LNG and continued use of coal with a market-based DER forecast that didn’t meet RPS milestones.

Dr. Matthias Fripp (on behalf of Ulupono and Blue Planet Foundation). Dramatically increased grid-scale solar PV and grid-scale wind resource potential on O‘ahu. Results showed a ten-fold increase in early renewable build for wind (assuming no additional development costs per kWh of output and without any land-based constraints, including potential community resistance to siting).

ACHIEVING OUR RPS ENERGY GOALS

Over each of the next four years, we steadily move toward meeting – and exceeding – the 2020 RPS milestone. This increase in renewable energy comprises mainly DG-PV (customer rooftop solar PV), and grid-scale solar PV, and grid-scale wind.

On track to exceed 2020 goal in 2018



NEXT STEPS

Next, our efforts will be focused on executing the near-term action plans while continuously reviewing long-term directions.

Our long-term planning provides useful directional insights. We have evaluated various long-term portfolios that include diverse sets of resources and input assumptions. For instance, over the upcoming months, we will be working to quantify the technical potential of rooftop solar. As noted earlier, two tools – Google’s Project Sunroof and Mapdwell’s Solar System – have the potential to provide us with improved data to help us better realize the true potential of DG-PV. We also plan to expand efforts to estimate resource potentials by area and relative proximity to our transmission system.

In this high DER environment, it is also important to develop the appropriate rate design to ensure optimum use of available DER resources and equity for all customers. We look forward to working on this issue under the Commission’s guidance.

We plan to maximize integrating DER and DR resources, and begin efforts to procure grid-scale resources. We recently issued a request for information (RFI) to landowners to help inventory potential parcels for renewable energy development. With Commission approval, we would also issue request for proposals (RFPs) for renewable grid-scale solar PV and grid-scale wind installations for all five islands. These RFPs directly flow from the resource acquisitions outlined in our near-term action plans and represent critical steps toward achieving the 100 percent RPS goal.

We plan to initiate additional studies and projects to modernize our grid to allow full and cost-effective integration of distributed and grid-scale resources. Included in this work are the necessary system security upgrades that ensure our transition to 100% renewable energy continues providing our customers with safe and reliable service.

Hawai‘i has the most ambitious renewable energy goals in the entire country. We believe that the proposed near-term action plans are critical to setting our state on a course to achieving those goals. And with all of us working together as a state, we are confident that Hawai‘i will remain a clean energy world leader for the decades to come.